UNIVERSIDAD POLITÉCNICA
DE MADRID

FACULTAD DE INFORMÁTICA

MÁSTER UNIVERSITARIO EN INGENIERÍA DEL SOFTWARE –
EUROPEAN MASTER ON SOFTWARE ENGINEERING

What Do We Know About Successful Software Project Factors

Master Thesis

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Madrid, June 2013

This thesis is submitted to the Facultad de Informática at Universidad Politécnica de Madrid in partial fulfillment of the requirements for the degree of Master of Science on Software Engineering.

Master Thesis
Master Universitario en Ingeniería del Software – European Master on Software Engineering
Thesis Title: What do We Know about Successful Software Project Factors
Thesis no: EMSE-2013-01
June 2013

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What do we know about Successful Software Project Factors

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ABSTRACT

This dissertation discusses how different practitioners define project success and success factors for software projects and products. The motivation for this work is to identify the way software practitioners' value and define project success. This can have implications for both practitioner motivation and software development productivity. Accordingly, in this work, we are interested in the various perceptions of the term "success" for different software practitioners and researchers. To get this information we performed a systematic mapping of the recent year's software development literature trying to identify stakeholders' perceptions about the success of a project and also possible differences among the views of the various stakeholders of a project. Some common terms related to project success (success project; software project success factors) were considered in formulating the search strings. The results were limited to twenty-two selected peer-reviewed conferences, papers/journal articles, published between 2003 and 2012.

Keywords: Project success; success factors; success criteria; software project success factors; systematic map.

DEDICATION

There are number of people, without whom this thesis might not have been written, and to whom I am greatly indebted.

First and foremost, I have to thank my parents for their love and support throughout my life. Thank you both for giving me strength and encouragement to follow my goals, you have actively supported me in my determination to find and realize my potential. My sisters Mehrangiz, and Mahsa have never left my side and are very special.

To my dear Fiance, Mehdi, for his presence throughout the entire master program. A very special thanks to you for your practical and emotional support, you have been my best cheerleader.

I also dedicate this dissertation to my grandmother and my aunt whose kind supports makes me able to reach at this stage of my life. Nothing can compensate their efforts and mental supports for me during my stay away from my country

ACKNOWLEDGMENTS

Apart from the efforts of myself, the success of any project depends largely on the encouragement and guidelines of many others. I take this opportunity to express my gratitude to the people who have been instrumental in the successful completion of this thesis. I would like to show my greatest appreciation and gratitude to my supervisors Ana Maria Moreno, and Lawrence Peters for their useful comments, remarks, engagement, and problem solving approach, through the learning process of this master thesis and for kind feedbacks.

Also, I like to thank my committee members who were more than generous with their expertise and their precious time during the process of interviewing.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

Software Engineering (SE) projects are substantially different from other engineering projects (e.g.: civil, industrial, etc.). This is due to the intangible nature of software that creates a non-stable context during project execution. This results in a common set of problems and reduces the probability of success. In 2009, Standish Group report, "CHAOS Summary 2009," showed a marked decrease in project success rates, with thirty-two percent (32%) of all projects succeeding, forty-four percent (44%) were challenged, and twenty-four percent (24%) failed. These 2009 numbers represent a downward trend in success rates from previous studies, over a decade (Group, 2009). It is therefore worthwhile to investigate factors that determine whether or not a project will be successful.

Numerous authors have identified a variety of factors that are critical to the success of a software project. In fact, most software projects that are completed late, over-budget, and fail to meet customer requirements are actually characterized by non-technical, people related problems often experienced during the early phases of the development process (Linberg, 1999). Hence, it is important that all project stakeholders, particularly project managers, understand what is important to the developers' perception of project success. This will ensure that a productive and creative work environment is supported (McConnell, 1996); such an environment in turn, can lower the overall risk associated with software development projects.

In general, it is difficult to define a concept like "success", as the viewpoint of project stakeholders may differ based on their job, organization culture and system related goals of the organization in which they work (Klein & Jiang, 2001). It has been suggested that most project managers do not understand how to define a successful project or how to characterize project success (Linberg, 1999). However, we posit that an agreement among the different software project stakeholders on the factors that result in successful projects, makes it is easier to achieve better teamwork. In other words, the truly successful project would be the one that is considered successful by all stakeholders, so the win-win evaluation is possible when there is a minimal conflict

between success factors and characteristics chosen by stakeholders of different perspectives (Boehm & Ross, 1989).

The remainder of this work is organized as follows: Section 2 gives a brief background and summarizes the related work. Section 3 discusses the research methodology and explains different steps of conducting the systematic map to provide us the knowledge about the different perceptions of success by the software project stakeholders. The results of the study are presented in Section 4, and finally conclusions and future research directions are presented in Section 5.

2. BACKGROUND AND RELATED WORK

Successful software projects have been described in many research works as projects that are completed within budget, on schedule, and that meet business objectives (Baccarini, 1999), (Linberg, 1999), and (Jones, 1995). We observed different opinions about the effect of schedule and budget factors on project success. More concretely, according to Lewis (2001), project success could be defined as meeting performance requirements, cost requirements, time restrictions, and project scope. Accurate and complete requirements are one of the most important factors which play a vital role for making a project successful. Following, we will discuss them in our systematic review. However, the results of our systematic review are similar to the results of Wateridge (1998) which came to the conclusion that “meet user requirements” is the most important input success criteria for projects, both for users and project managers.

On the other hand, Linberg (1999) and Procaccino and Verner (2002) found that project success and important factors for project success are perceived differently among different industry domains, different cultures and countries.

Our aim is to analyze recent literature, which discusses the most recurrent factors associated with successful projects. We would like to confirm whether the traditional success factors, previously mentioned, still keep on being the most relevant ones, or if some other factors have arisen in the last few years. We would also like to confirm

different perceptions among different roles, domains or cultures about project success and the details of these differences.

3. RESEARCH METHOD AND CONDUCT

This research was initially designed to be a systematic literature review following the guidelines provided by Kitchenham and Charters (2007). Due to difficulties in finding experiments, we moved into a wider approach starting with a systematic mapping. The guidelines on how to conduct a systematic review were considered along with guidelines provided for performing a systematic map by Petersen et al (2008). This report presents all steps taken in designing and conducting the systematic review, and presents the results employing the systematic mapping guidelines.

3.1. Research Questions

In order to answer these questions, the current research literature had to be explored, the information selected as sentences had to be itemized and the duplicates needed to be identified. Regarding the need for conducting a systematic literature review in the area, the research questions for this study were as follows.

R.Q.1: Over the last decade, what are the most important factors leading to successful software projects?

R.Q.2: How do different stakeholders perceive software project success?

3.2. Search Strategy

The research started with defining a suitable scope, which was initially set to all the different perceptions of software project success and the most important factors that leads to project success. It led to formulating a preliminary set of research questions,

and identifying the keywords. The initial keywords were searched in well-known databases such as ACM Portal and IEEE Xplore. Based on the search results, the research scope, research questions, and keywords were refined, search strings were reformulated, and searches were re-conducted. Moreover, the list of databases was expanded to collect as many relevant papers as possible. In parallel, a list of key papers was generated, which was used as a validation list to ensure the reliability and relevancy of the searches and to evaluate the search strings. The summary of the process is shown in Figure 1.

3.3. Data Sources

In a progressive process as discussed previously, the databases were decided as follows:

1. **ACM Portal** (http://portal.acm.org): This provides a collection of citations and full-text from ACM journal and newsletter articles and conference proceedings and covers IT and programming areas. The Association for Computing Machinery (ACM) is a US-based international know society for computing. Unlike the IEEE, however, the ACM is solely dedicated to computing.

2. **IEEE Xplore** (http://ieeexplore.ieee.org): It covers electrical engineering, computer science, and electronic subject areas, and provides full-text and bibliographic access to IEEE transactions, journals, magazines and conference proceedings published since 1988. The database mainly covers material from the Institute of Electrical and Electronics Engineers (IEEE) and the Institution of Engineering and Technology. Nowadays, IEEE Xplore database contains over three million records.

3. **Web of knowledg**e (http://apps.webofknowledge.com/): Web of Knowledge is an online academic citation index provided by Thomson Reuters. It is designed for providing access to multiple databases, cross-disciplinary research, and in-depth exploration of specialized subfields within an academic or scientific discipline. As a citation index, any cited paper will lead to any other literature (book, academic journal, proceedings, etc.), which currently, or in the past, cites this work. In addition, literature which shows the greatest impact in a field a covered by Web of Science, or more than one discipline, can be selectively obtained.

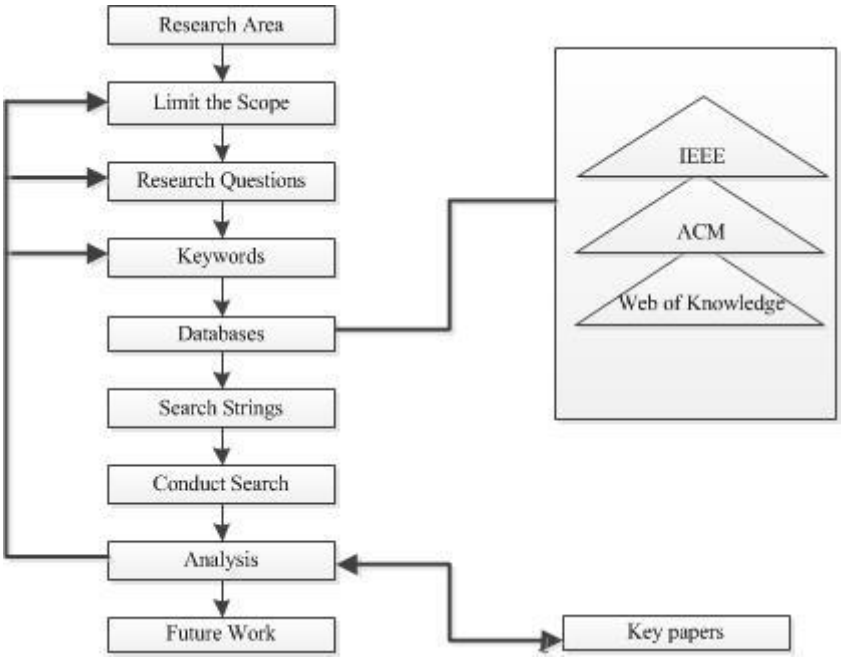

Figure1: Search strategy and process

3.4. Data Retrieval

We decided to create a list of search strings with the following structure: (main concept AND specifier) where search strings were formulated by combining different successful factors, success criteria, project success and in different types of software

project, software engineering, and software development. It can be summarized as: (X1 OR X2…OR Xn) AND (Y1 OR Y2…OR Yn), where X includes successful factors or successful criteria or success project and Y includes software engineering or software project or software development as presented in the following:

X: {Successful Factors, Success Criteria, Project Success}

Y: {Software Engineering, Software Project, Software Development}

We limited the search strings to a time span that goes from 2003 to 2012 in all of data sources that we used with the content type ”Conference Publications” and ”Journals & Magazines”. These two content types covered almost 100% of the results together, and regarding to the ACM Portal, we limited to ACM publications and affiliated organizations with the purpose of summarizing the updated relevant related works in recent years. We just reviewed the peer-reviewed publications; the gray publisher has not been explored. The written language was set to be English. In order to limit the number of irrelevant hits, the search places were limited to title, abstract and keyword.

3.5. Selection Process

A three-stage approach was used in the selection process. The first stage involved the selection of studies based on their titles. At the title level, obvious irrelevant studies were removed. If there was any doubt about selection based on the title only, the study was kept. The second stage involved the selection of studies based on their abstracts. At the abstract level, the focus was on selecting experience, opinion and literature review studies. Purely theoretical models and historical recapitulation were excluded at this stage, as our goal with this review is to provide conclusions based on experienced data. The last stage involved the selection of studies following a summary overview. The overview focused on the main elements of the studies: introductions, conclusions, tables, and figures. The goal at this stage was to perform a preliminary quality evaluation to determine whether the conclusions of the studies were justified

3.6. Inclusion Process

The steps taken to extract the final set of studies for further synthesis are summarized in Figure 2. The studies remaining at this stage were carefully read. Any conclusion pertaining to developers was copied into a repository for further analysis. The evidence was extracted by the individual reviewers, and we used a standardized extraction process based on the previous work of Dyba and Dingsoyr (2008).

The searches resulted in identifying 589 papers. The decision on inclusion/exclusion criteria was mainly abstract-based due to the fact that the full-text was not available for many of the papers. This was due to the fact that it was too costly to order and pay for the papers and later discover that they should be removed from further analysis.

We excluded papers that were focused on specific software project or software development methods because our survey was about the general factors in successful projects. Based on the evidence found in the title, abstract or keywords implicitly or explicitly, the papers were categorized as “relevant”, “irrelevant” or “possibly relevant”.

Relevant papers are the ones that contain at least one topic related to the research questions. Possibly relevant papers, some of which we were uncertain about inclusion in this work; need more analysis in order to establish their relevance.

The number of selected papers within the three databases was 46 from 589 reviewed in total.

If the full paper was not accessible, an email was delivered to the main or second author asking for the paper in PDF. At the analysis step of this study, two emails remained unanswered, so those two papers were excluded. In addition, papers with no result or the same content as other studies were excluded. Thus, 22 studies were finally selected as primary papers for data extraction and synthesis.

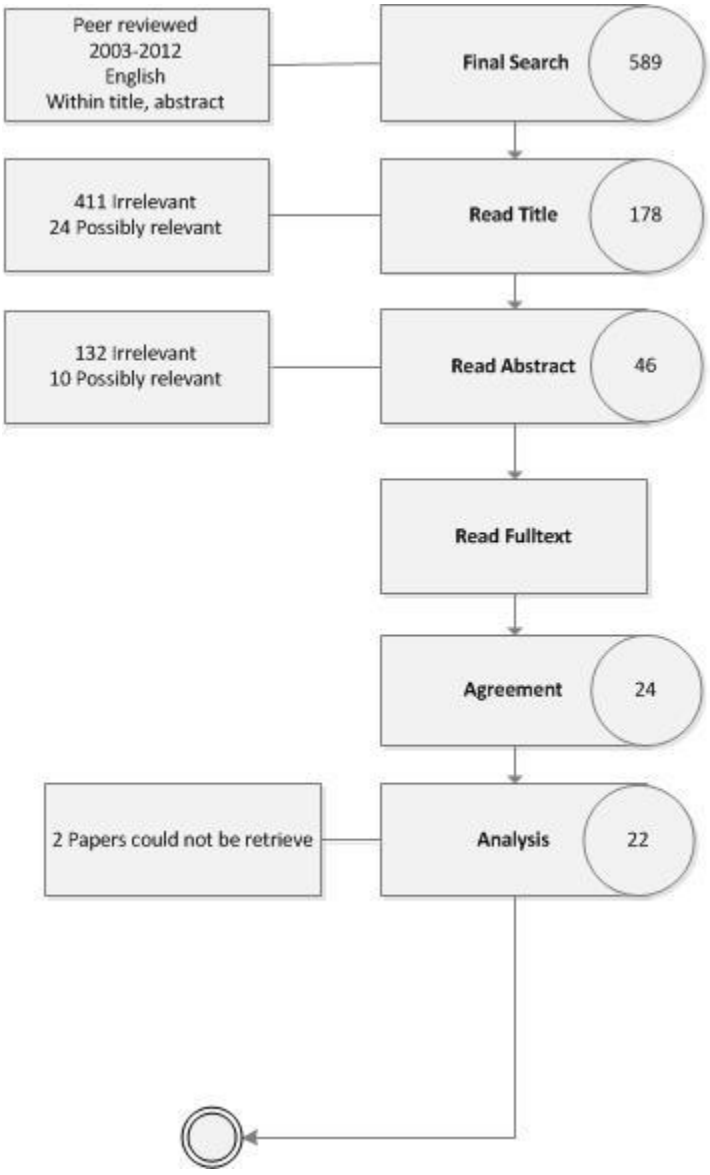

Figure2. Inclusion process and results

3.7. Data Extraction and Synthesis

The guidelines provided by Petersen et al. (2008) were used to build the classification scheme. We decided to concentrate on papers with some exceptions but in every case we considered at least half of the paper.

Mendeley Desktop was used for data extraction and collection as well as bibliographic references and for looking for possible duplicates. Every success factor was selected regarding the objectives formulated for this study. We found a list of sentences or paragraphs that represented factors of relevant information. We summarized the factors looking for duplicates and we classified them. Then we explained the details of any relevant sentence in the explanation of the results. Finally, several descriptive classifications of the content of the studied papers were made with respect to research methodology, empirical background, findings, participants, and context of the studies.

4. Results

This section presents the data we collected by reading the full text of each included paper and conference.

4.1. Result of literature review

The outcome of the selection phase was 22 articles and conference proceedings (see appendix). Table 1 shows the number of papers for each studied year (2003-2012). The maximum number of papers belongs to year 2006 with 5 papers, and also a few papers in 2003, 2004, 2008, 2011 and 2012.

This could point to a decreasing interest in finding the success factors that lead to software project success since 2011.

Table 1. Distribution of papers over the studied years

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
ACM				2	1		2	1	1	
IEEE		1	1	1			1			
Web of Knowledge	1		3	2	2	1		1		1
Total	1	1	4	5	3	1	3	2	1	1

The classification scheme suggested by Wieringa et al. (2006) and used later by Jalali and Wohlin (2010) was also used in this study for determining the research type of the relevant papers. We modified this scheme by adding the new category of literature review and gathering philosophy and opinion research together. We added literature review since the concept of reviewing the literature doesn't need to fit any of the categories. A literature review could be a paper that is not trying to provide a solution, or validate a novel study or evaluate an approach in practice but just to collect information related to previously defined questions. Regarding philosophical and opinion categories, we found it difficult to distinguish between them since philosophical papers imply an opinion. A short description of each category is also provided:

1. **Evaluation Research:** Techniques, which are implemented and evaluated in practice, and the consequences, are investigated.

2. **Validation Research:** A novel study, typically a laboratory study that has not been implemented in practice.

3. **Solution Proposal:** A solution for a problem is proposed, and the benefits are discussed. The difference between a solution proposal and a validation research is in the level of abstraction for suggested solutions, which is higher for solution proposals.

4. Philosophical / Opinion Paper: A new way of looking at the current status of certain topic or author's opinion not relying on related works and research methodologies.

5. Experience paper: The authors describe their own experience.

6. Literature review: the authors try to answer a set of questions by reading the current literature.

The results of our research are presented in Figure 3. This figure shows that the majority of the current literature is based on practitioners reporting on their own experience.

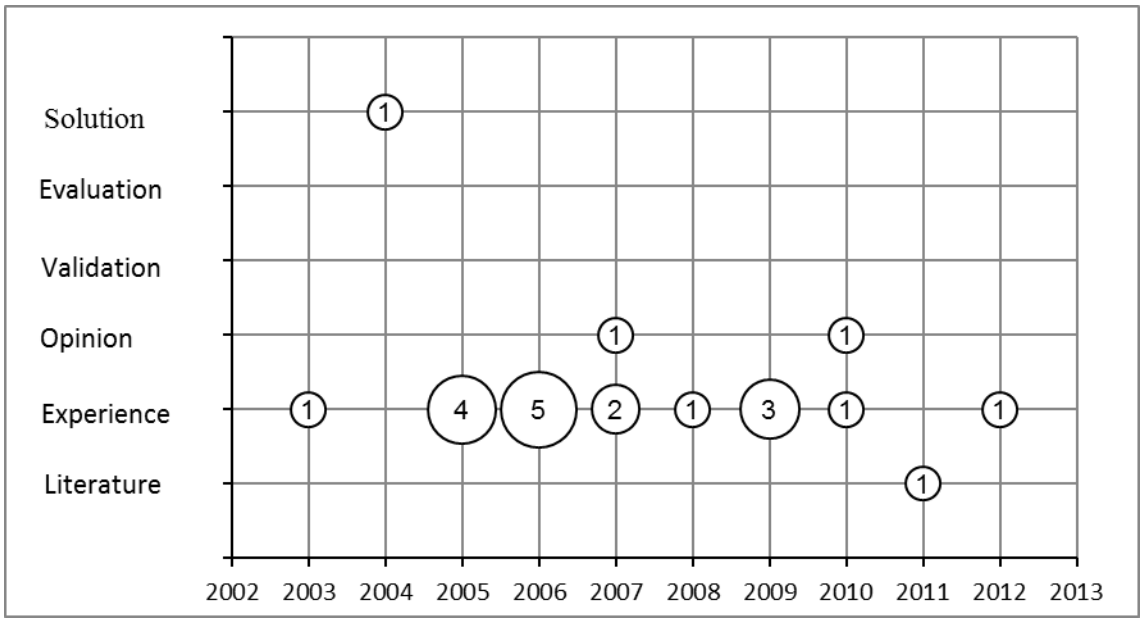

Figure 3. Distribution of research types over the studied years

We could not find in this literature review any article based on the evaluation and validation research. The distribution of different research types over the studied years pinpoints the need for conducting more validation, and evaluation researches. Although

experience reports are valuable, evaluation and validation research with rigorous research method are required to establish foundations for a more mature practice.

Among all 22 included papers and proceedings, 18 of them were empirical studies. 15 papers out of them were written in different industry domains, where the authors of the papers made an investigation of different practitioner's roles in the particular organizations and companies, 2 investigated the academic case and one was a joint paper between these two areas. The other four were non-empirical and were written for the particular organizations and companies.

Most of these 22 articles and proceedings, focused on large projects and organizations and a long time period. The project size was judged based on the following criteria: small<=20-person<medium<=50-person<large. The duration was considered short if it was less than one month and long if it was longer than 7 months.

Below we present the answer to each of our research questions.

4.2. What are the most important factors leading to successful software projects?

By reviewing the relevant articles and proceedings, we realized that the literature distinguishes between what we have named input success factors and output success factors. Applying input success factors may help software teams and developers to be more successful. On the other hand, output success factors are assessed in order to determine whether the project can be considered successful or not.

Therefore, we split the first question of our research into two sections:

RQ1.1. Which are the most important success factors that a project requires in order to deliver good results (input success factors)?

RQ1.2. Which are the most important success factors that assess whether a project is successful or not (output success factors)?

Below we discuss each sub-question.

4.2.1. What are the most important input software project success factors?

Based on the results of our systematic mapping review, we categorize the input success factors in to 6 groups.

The input success factors are:

- Good requirements
- User involvement
- Team skills
- Team working and communication
- The project manager role
- Planning and project goals

These 6 input success factors are demonstrated in Figure 4 according to their frequency of appearance in the studied papers. Below we describe and discuss these factors. Table 2 shows the detailed references where the factors are mentioned.

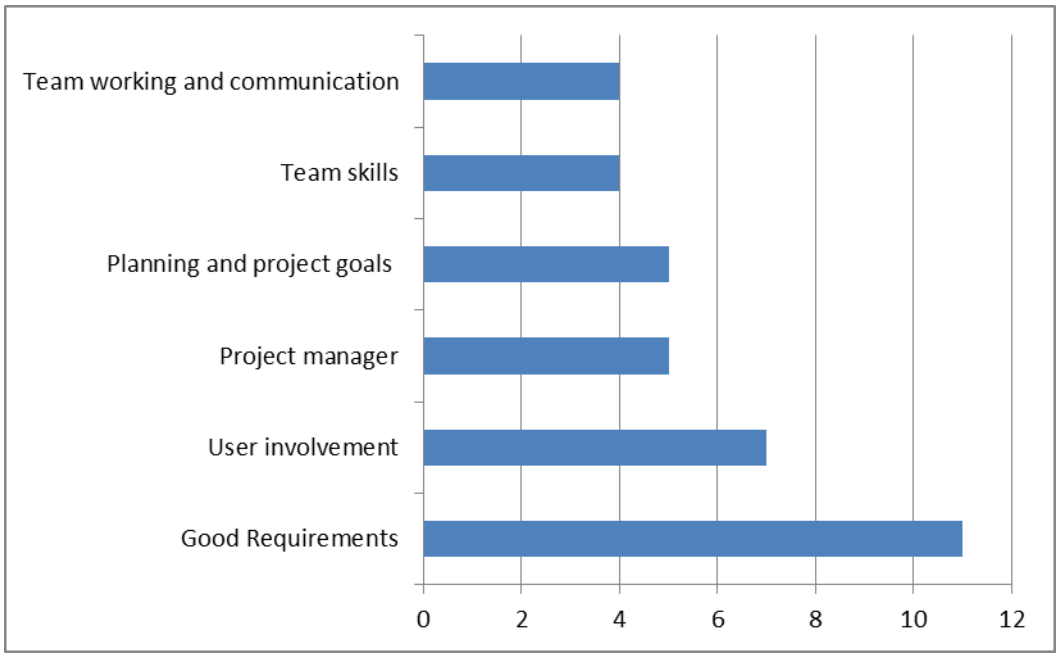

Figure4. Successful input factors in the studied papers

Table 2. Successful input factors relationship with relevant articles and conferences.

	Good Requirements	**User Involvement**	**Project manager role**	**Planning and project goals**	**Team working**	**Team skills**
(Berntsson-Svensson & Aybüke, 2006)	X	X	X			
(Egorova et al. 2009)	X					
(Evanco & Verner, 2005)	X		X			
(Germán et al. 2012)	X	X	X	X		
(Ikonen & Kurhila, 2009)					X	X
(McLeod, 2011)	X	X		X		X
(Milosevic & Patanakul, 2005)			X			
(Nindel-Edwards & Steinke, 2007)	X					
(Pereira et al. 2008)	X				X	
(Pozgaj et al. 2004)				X		
(Procaccino et al. 2006)	X			X	X	X
(Procaccino & Verner, 2009)	X	X			X	
(Sumner et al. 2006)		X	X			
(Verner et al. 2005)	X					
(Weisstein et al. 2010)		X				
(Wohlin and Andrews, 2003)				X		
(Xu et al 2010)						X
(Yousef et al. 2006)	X	X				

Good requirements:

An accurate and complete set of requirements is one of the most important input factors, for making a project successful. This factor is included in more than half of the studied articles and conference proceedings.

In an empirical study done by Evanco et al. (2005), and Verner et al. (2005), 101 software practitioners at large financial and commercial organizations were surveyed. These 2 articles were written based on the same investigation talking about the important role of requirements in software projects. Later on, in this thesis you will see that Verner et al. (2005), only focuses on requirement factor while Evanco et al. 2005 discussed not only the requirement factor but also the role of project manager factor. Their research showed that requirements were managed effectively and were accurate and complete, in 93% of successful projects. They also concluded that if the requirements were incomplete at the beginning, completing it during the project influenced project success. They did not find any relationship between project success and changing requirements during the project.

Berntsson-Svensson and Aybüke (2006) investigated the data which were collected from 27 software projects at 11 companies in Sweden and Australia. They made a surveyed software practitioners and managers from 3 different industries. They found that two factors in financial services, consulting, and telecommunications industries were considered as important input factors for project success: (1) complete and accurate requirements from project start and (2) having enough time for requirements' elicitation; However less than a third of the successful projects started with complete requirements. They explained why projects start without complete and accurate requirements while the requirements are so important to the final project results. Time to market and requirements elicitation, are the reasons for not being able to collect good requirements at the primary stages of software projects. However, their results show that having complete requirements during the project itself were only found to be related to the success of projects in the telecommunications industry and did not have any effect on the success of software in the financial services and consulting industries. One explanation for this difference is that requirements were completed during the project

for both the successful and failed projects for the financial services and consultants and therefore could not be seen as a success factor.

Egorova et al. (2009) have analyzed data from two empirical studies conducted in 2005 in Australia and Sweden and in 2007 in Italy on 72 participants. Their results show top managers and other strategic stakeholders agreed that complete and accurate requirements in the project are necessary for project success. Strategic and operational stakeholders also mentioned meeting quality requirements as one of the most important project characteristics for success.

In McLeod's research of 177 empirical papers; well-defined and clearly stated user requirements in the development process were associated with project success (McLeod, 2011).

Pereira et al. (2008), did exploratory research among Chilean software practitioners in software development organizations, and compared their results with a survey of American software practitioners, for understanding the cultural differences in the perception of project success. Their study showed that the respondents in the US study are more product-focused and on meeting user requirements, while the Chilean respondents are process-focused; they ranked estimation and schedule highly. Consequently, they thought that US practitioners were less risk-averse than people in Chile because they are more interested in satisfying the user requirements and product needs than in schedule estimates.

Procaccino et al. (2006), made a survey of 30 developers in the U.S, from 20 organizations in the commercial, government, and academic areas. One of the three highest ranked components for all practitioners was when the requirements are clear and comprehended completely by the development team (90%). They found that understanding requirements, particularly at the early stage, will help save expensive and time-consuming rework, which contributes to project success from both the perspective of the developer (an internal view) and the customer/user (an external view).

In Yousef et al. (2006) research, a web-based survey and interviews were done to discover common characteristics and rules that govern project success in project management, system analysis, development, software configuration management and

quality assurance groups. They found out, the most important points that lead to project success from the responders' point of view (especially the management point of view), is the requirements, as it result in well-defined software deliverables.

Nindel-Edwards and Steinke (2007), made an opinion view for software development in order to show the importance of requirements as an input to the software development team. Based on their research, the software project team could create a detailed test plan during the requirements' phase, which will clarify most of the requirements and thereby lead to more successful software development projects. They have studied other articles to show that constantly testing the product against this test plan may significantly improve overall product quality. They found that developing a thorough test plan, bringing to light all requirements during the requirements engineering phase reduces the likelihood of missing requirements and discovering them late in the development effort when they are more expensive to repair.

Procaccino and Verner research (2009), collected data from 53 project managers and 12 practitioners in the United States, through an online survey. They examined software development success and its relationship to the process of developing software. Requirements management found to be one of the highest overall ranked categories by both project managers and practitioners in this survey.

In Germán et al. (2012), project managers with more than 5 years experience who work in different countries across LATAM region (Argentina, Uruguay, Chile and Colombia) were interviewed. One of the important factors for them was requirements management, as it is one of the biggest problems in IT development projects. They thought it occurred due to a lack of knowledge of users of the application, which is to be developed. In addition they found out that it is also difficult to generate a correct communication synergy between users and functional analysts, who are responsible for getting the software requirement specifications.

User involvement:

User involvement is one of the effective input factors in successful software projects.

Sumner et al. (2006), used questionnaires from 112 project managers, for identifying the characteristics of IT project leaders related to project success. They found out, user involvement and effective communication with end users are critical to project success.

Yousef et al. (2006) observed that from the responders' point of view (especially management's point of view), when customer/user stays involved right through the project, it helps the project deliver more successful results.

In the survey of Weisstein et al. (2010), data were collected from 746 respondents, in 117 software development projects, in order to investigate the impact of user participation on the satisfaction of both developers and users. Their findings offer insights into the impact of user participation in generating higher levels of developer and user satisfaction and, at the same time, minimizing the perception gap between users and developers on project performance. However, at high levels of user participation, interaction between users and developers can generate unnecessary conflict and increased rework of software features. At the same time, software developers are likely to be unhappy with over demanding customers/users. Increased conflict is likely to result from frequent and over scrupulous changes suggested by customers on an ongoing basis.

Berntsson-Svensson and Aybüke (2006) observed that the services of industrial financial subjects were the only ones that thought customer involvement was one of the important input factors that help the development team in order to have project success.

Procaccino and Verner (2009) observed that from the developers' point of view user participation in information system development lead to greater user satisfaction with the system. Involvement, and subsequent satisfaction, can also lead to higher usage of the system and a greater likelihood that users will perceive the system as being useful and users feel that they were involved in the decision process.

For German et al. (2012), one of the important factors for achieving user involvement is identifying them and defining their responsibilities. They found that this identification process could be either simple or require a major effort. They found that communication to key users should be clear about when they will participate in the project during the project life cycle. It is also critical to be aware that key user's

participation is not only limited to the requirements definition phase. They should participate in each software delivery acceptance test and must be involved in managing the cultural change process.

In McLeod (2011), active participation of users in systems development is one of the input factors that have an impact on successful project outcomes.

The Project Manager Role:

The project manager is one of the important input factors, to ensure desirable final results in software projects.

Evanco and Verner (2005) found the best predictor of project success occurs when the project manager has a clear vision of the project. They found that changing the project manager was significantly negatively correlated with project success. Also, the experience of the project manager and his/her background in the area were not significantly related to project success. Finally management support of the development team is essential to motivate the team to work effectively toward organizational goals, and appreciating and rewarding the staff who worked long hours are associated with project success.

Sumner et al. (2006) found that the management and leadership skills of the project manager was one of the key factors affecting IT project success. This, results in involvement and effective communication in the information systems development project.

The survey of Germán et al. (2012) found that a key to success in software projects was the support of a senior manager who has an influential position within the company and is committed to mitigating risks and solving issues that the project team cannot resolve on their own. Qualified project managers are input factors that help team members to get appropriate results.

Milosevic and Patanakult (2005) did a case study, on electronics, computer and software industries. They did a literature review and interviewed and carried out a

questionnaire-based survey. The final version involved 55 projects. The survey involved project directors, project managers and team members. Their results showed that the project management (PM) process was counted as an important success factor in the development of projects. They found that standardizing the project management process development lead to project success. They found that team-based project organizations are more successful than those without such organization and standardized project management metrics.

Berntsson-Svensson and Aybüke (2006) empirical studies found that most of the successful and failed projects in the financial service sectors and telecommunications industries had experienced project managers. In the consulting industry, experienced project managers had more failed projects than successful ones.

Planning and project goals:

One of the input factors that we found to be associated with project success was planning and project goal.

Wohlin and Andrews (2003) did an empirical study on 46 selected software projects. They found that ‘‘project planning’’ and ‘‘ability to follow the plans’’ are crucial project characteristics to obtain a successful project.

Pozgaj et al. (2004) carried out research based on actual problems encountered on software development projects in Ericsson Nikola Tesla Company. The importance of initial project estimations and plans is recognized as one of the main issues of successful project preparation. They concluded that a proper technology selection is also important for successful realization because the effort required to build the software system is directly related to the technologies used.

Procaccino et al. (2005) found that practitioner’s motivation is one of the important factors having the single greatest impact on practitioner’s productivity and the attainment of project goals. From the perspective of the practitioners, motivation is the intrinsic and internal engine, which makes practitioners feel positive about what they

made. It is related to the positive outcome of projects but cannot be evaluated fully until the end of the development process.

McLeod (2011) showed that the success of one project is associated with the following issues:

- Use of appropriate technology
- Clear, well-defined and well communicated project content
- Use of an appropriate standard method of systems (A standard method of software systems development is a formal or documented set of procedures for directing or guiding development by an organization (Iivari et al. 2001))

Germán et al. (2012) found that adequate project planning is a strategy that the project team must follow in order to achieve project objectives. Addressing this factor is really helpful in software development projects, and it helps manage a high degree of uncertainty.

Team skills:

We categorized below, some of the different criteria that are related to the team skills group, considered to effect project success.

In Procaccino et al. (2006), one of the three highest-ranked components in the view of all software developers in commercial, government, and academic organizations was when the development team had sufficient skills.

Xu et al. (2010) conducted an extensive literature review and proposed that perceived IT infrastructure capabilities have a positive impact on perceived likelihood of project success. Their study clearly showed that IT infrastructure capabilities of an organization are highly important and relevant to IT project success.

Ikonen and Kurhila (2009) surveyed and interviewed the 40 students who participated in capstone projects. Based on their results, prior skills, personal

competence, and positive attitude toward a project has much more impact on the project success.

McLeod (2011) classified factors that have an impact on project outcomes. They found that adequately training users and having committed users with realistic expectations of the system enhanced the project's success.

Team working and communication:

By reviewing the articles, another input factor seemed to benefit software projects communication and teamwork

One of the three highest-ranked components in the view of all software developers in the survey done by Procaccino et al. (2006) was the development team having a cooperative and mutually responsive relationship.

To enjoy working with the team was ranked the highest factor in the US survey while it is second in the Chilean study in the research carried out by Pereira et al. (2008).

Based on the results of Ikonen and Kurhila (2009), communication between users and the team, and clarification of the goals of the project have a remarkably positive impact on the project success.

Procaccino and Verner (2009) also concluded that effective communication between users and the development team in everyday regular work was related to a successful development process.

4.2.2. What are the most important output software project success factors?

At the end of this study, we assessed the output factors in order to measure the success level of our work. We categorized the output factors into 4 groups.

These factors are as following:

- Schedule and budget estimation
- Customer needs and satisfaction
- Job satisfaction
- Functionality, quality and performance

These 4 output factors are plotted in Figure 5 according to their frequency of appearance in the studied papers.

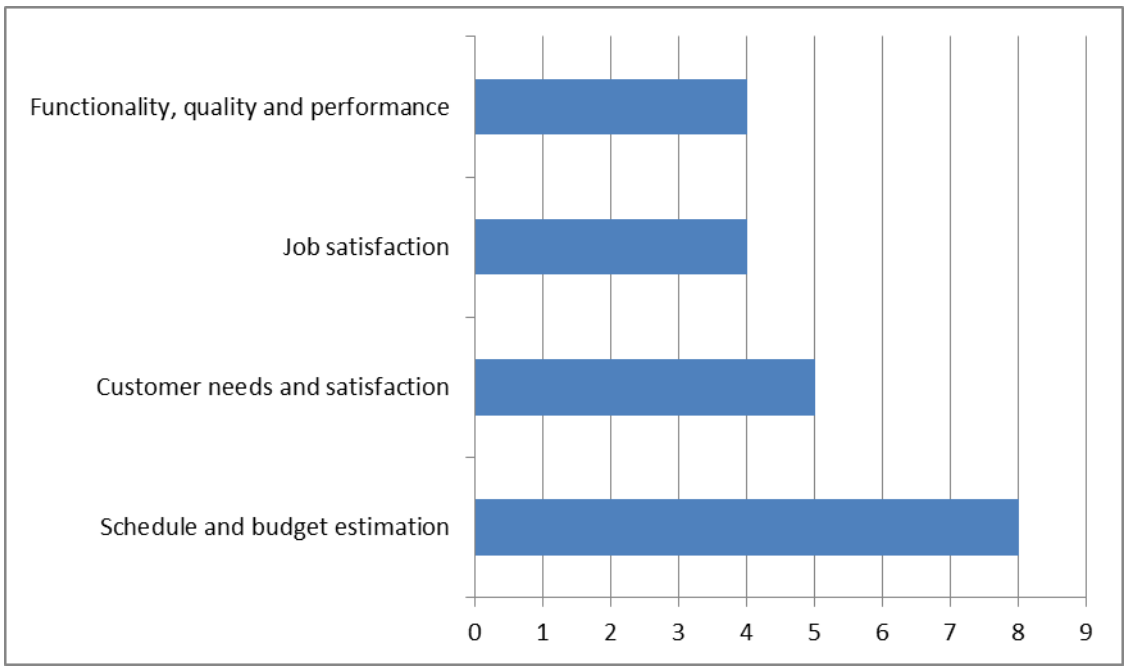

Figure5. Frequency of appearance successful output factors in the studied papers

Below we describe and discuss these factors. In Table 3 relevant articles and conference proceedings are referenced that are associated with successful output factors.

Table 3. Successful output factors relationship with relevant articles and conferences

	Schedule and budget estimation	**Meeting Customer needs and user satisfaction**	**Job satisfaction**	**Functionality, quality and performance**
(Agarwal & Rathod, 2006)	X			X
(Berntsson-Svensson & Aybüke, 2006)	X	X		X
(Dannelly & DeNoia, 2007)		X		
(Egorova et al. 2009)		X		X
(Ikonen & Kurhila, 2009)			X	
(McLeod, 2011)	X			
(Pereira et al. 2008).	X		X	
(Procaccino et al. 2005)	X	X	X	
(Procaccino et al. 2006)			X	
(Sumner et al. 2006)	X			
(Verner et al. 2007)	X			
(Wohlin and Andrews, 2003)	X			X
(Yousef et al. 2006)		X		

Schedule and budget estimation:

Schedule and budget estimation are important output factors that are used to determine if the final software project is successful or not. We found different viewpoints related to schedule and budget. These are discussed below in the context of our findings in the related articles.

For the research that has been done by Procaccino et al. (2005) finishing a project within estimated budget, which is a component of the traditional definition of project

success (Baccarini, 1999), (Jones, 1995), (Linberg, 1999), was ranked lowest among process project items. From a software developer's point of view, producing a quality system that meets customer/user requirements has more value than delivering that system on time and within budget.

In the Berntsson-Svensson and Aybüke (2006) empirical study, software practitioners and managers from the financial services, consulting, and telecommunications industries gave the least importance to the schedule target factor. Adding extra personnel in the financial services and consulting industries in order to meet the project schedule also was found to be related to project failure. On the other hand, in Sumner et al. (2006) work to achieve project due dates is an important metric for project and project leader success.

Chilean software practitioner experiences are process-focused. They gave top rankings to the estimation factor. These results were reported in Pereira et al. (2008).

In the Wohlin and Andrews (2003) empirical study, Timeliness of delivery is the most important success variable from different software practitioner's point of view.

In Agarwal and Rathod (2006), time and costs were ranked 3 and 4 in importance, respectively, by different interest groups of software professionals, namely developers, project managers and customer accounts managers.

Adequate time, financial and human resources were the important success factors for project content in McLeod (2011).

In Verner et al. (2007), from the developers' point of view accurate estimates are instrumental in perceived project success. Poor estimates will lead to deviations of results from the estimates, making it difficult to justify a project as being successful. Good estimates are made with appropriate requirements information and adequate staff, such projects will not have schedule changes, developers will not have input into their schedules, and staff will not be added late to meet an aggressive schedule. They concluded that adding staff late to meet an aggressive schedule is still a problem and is significantly correlated with both management's and developer's views of project failure.

Meeting Customer needs and user satisfaction:

Meeting customer needs and requirements, making ease of use, learning product features, user friendly systems, and satisfaction of the customer with the software product have been found to be important factors in achieving success of software project success.

Berntsson-Svensson and Aybüke (2006) showed that the subjects from all financial, consulting and telecommunication industries agreed that a "satisfied customer" was the most important factor for product success.

In an online survey of 30 developers in 20 organizations about their perception of project success in the United States, Procaccino et al. (2005) concluded that developers placed importance on meeting customer's needs. For example, ease of use and meeting customers/users requirements.

Dannelly and DeNoia (2007) explored the factors that students believe are important for measuring the success of professional software development projects. The students were divided in to four groups of sophomore computer information science majors (So CIS), senior computer information science majors (Sr CIS), sophomore computer science majors (So CS) and senior computer science majors (Sr CS). One of the most important factors rated by these 4 groups was when the product is based on customer's needs. This results in; the customers finding that the products are useful and easy to use.

Egorova, et al. (2009) Found, success occurred when there was an agreement between stakeholders on the definition of what a successful project and product is. In fact the majority of the respondents agreed that "satisfied customer" is the factor that characterizes successful products.

Providing realistic expectations from customers and users is a characteristic that also contributes to highly successful project (Yousef et al. 2006).

Job satisfaction:

Correlation between success and the importance of job satisfaction, and professional status enhancement was high in the results of (Pereira et al. 2008), (Ikonen & Kurhila, 2009) articles.

In Pereira et al. (2008), a pleasant work environment and job satisfaction among Chilean practitioners was considered one of the important factors that lead to project success. Student responses in Ikonen and Kurhila (2009) showed there is a high correlation between success and job satisfaction.

Procaccino et al. (2005) found that the second highest ranked factor in work related components is having a sense of achievement. This is an intrinsic need, also in the Procaccino et al. (2006) survey. That is project success from both the perspective of the developer (an internal view) and the customer/user (an external view) had a sense that sufficient quality was delivered, a sense of achievement, and were provided with enough freedom and independence to be successful.

Functionality, quality and performance:

Functionality and quality of software product appears to be the most important success criterion for judging its performance based on the results of (Agarwal & Rathod, 2006), and (Egorova et al. 2009).

Agarwal and Rathod (2006) surveyed three potentially different interest groups of software professionals namely developers, project managers and customer account managers. For software project internal organizations, accomplishment of the scope (i.e., functionality and quality of the software product) appears to be the most important success criterion for judging its performance. When it comes to choosing between functionality and quality, software professionals tend to give more importance to functionality. Functionality, quality, time and cost have been given the respective ranks 1 through 4 equivocally by all professionals. They saw that functionality and quality go hand-in-hand except in the eyes of customer account managers. Their findings are

useful for the software industry in terms of managing its resources in such a way that the focus of professionals on functionality can be channeled to meet project priorities and customer satisfaction.

Quality of software is the second most important success variable, from different practitioner's point of view, In the Wohlin and Andrews (2003) empirical study.

In Egorova et al. (2009) research, there was an agreement between stakeholders on the definition of a successful project and product. In fact the majority of the respondents agreed that "great quality" characterize successful products.

A working product was considered as an important output factor in the views of both the consulting and telecommunications industries in Berntsson-Svensson and Aybüke (2006).

We found in our literature review that project success factors are derived from success oriented input and output factors. Applying all of the aforementioned successful input factors results in successful output factors. This is because the successful input factors act like a catalyst for assuring and obtaining more successful output factors which result in successful projects. Successful input factors are the factors that we used in the early phases or during the development of one project that helped and influenced our final work, while successful output factors are the perceived factors at the end of the project.

4.3. How do different stakeholders perceive software project success?

Based on the results of these 22 reviewed articles and conference proceedings we conclude that different stakeholders involved in software development may attribute success to different indicators. Analogously they may support different factors considered the root of successful projects.

Egorova et al. (2009) have analyzed data from two empirical studies conducted in 2005 in Australia and Sweden and in 2007 in Italy on 72 participating organizations. They distinguished three types of perspectives: strategic, tactical and operational.

1) Strategic – This perspective summarizes the views of the company's business-oriented stakeholders, i.e. stakeholders' top managers, business analysts, and market experts.

2) Tactical – This perspective represents the views of those responsible for the daily software development process, mainly project managers.

3) Operational - This perspective is held by those company stakeholders that are directly involved in the product development.

Stakeholders of the first group are interested mainly in revenue and customers, since their work is evaluated depending on the ROI (return on investment) and economic benefits for the company. The second group is concerned about schedule and budget; they are judged by delivery precision and project cost, while stakeholders of the third group deal with software artifacts and their work is mainly evaluated based upon the quality of the final product.

In the Berntsson-Svensson and Aybüke (2006) empirical study, for software practitioners and managers from the financial services, consulting, and telecommunications industry types, two factors were considered as important for project success: (1) complete and accurate requirements from project start and (2) having enough time for requirements elicitation, also these 3 different industries gave the least importance factor to the schedule target of the project.

There was also a difference between financial services, consulting, and telecommunications industries when it came to the subjects listing the most important factors for project success. Below we explain these differences.

The financial services and telecommunications industries rate the influence of "good relations between personnel" on project success. This factor was seen as the most important factor for project success by subjects from the telecommunications industry,

while subjects from the financial services industry saw this as one of the least important factors.

Subjects from the financial services industry considered “overall good requirements” and “committed sponsor” as important factors for project success. These two factors were seen as two of the three least important factors by subjects in the consulting industry, while subjects in the telecommunications industry rated committed sponsor among the three least important factors for project success. It was surprising to see that a “good schedule” is not seen as an important factor for any of the industries. The financial services industry subjects were the only ones to consider customer involvement as important and also subjects from the consulting industry were the only ones to view “very good project managers” as an important factor for project success.

In Pereira et al. (2008) cultural differences led to different definitions of successful software projects when the software development had been outsourced to a country different from the country in which the software was to be used. For understanding cultural differences they investigated project success from the Chilean software development professional’s viewpoint and compared those results with the viewpoint of US professionals. They observed interesting differences between the results from the US and Chile surveys, specifically having to do with the personal definition of project success. Their study showed that the respondents in the U.S. are more product-focused and oriented toward meeting user requirements, while the Chilean respondents are process-focused; they ranked estimation and schedule highly. Consequently, they thought that U.S. practitioners were less risk-averse than people in Chile because they are more interested in satisfying the user requirements and product needs than in scheduling estimates.

On the other hand, we observed uniformity in the views of different stakeholders in (Agarwal & Rathod, 2006) and (Procaccino et al. 2005) articles.

In Agarwal and Rathod (2006), the authors surveyed three potentially different interest groups of software professionals namely programmers, project managers and customer account managers. The respondents were asked to rank time, cost, functionality and quality in terms of their importance in defining project success. They found surprising

uniformity in different constituents of this particular group of stakeholders and all of them overwhelmingly considered meeting the scope of software projects, which comprises the functionality and quality of the project, as the highest determinant of success. When it comes to choosing between functionality and quality, software professionals tend to give more importance to functionality. Between cost and time, software professionals tend to rate the project time as more important factor for defining success. A limited number of software professionals also considered customer happiness, satisfaction and project specific priorities as important criteria in addition to the three core parameters.

In Procaccino et al. (2005), 66 software practitioners, including software developers, programmers, data base developers, and system analysts participated in a study. The results indicated the existence of software practitioner agreement on intrinsic items like internally motivating work, meeting customer' needs, and easily applied product, also finishing a project within budget which is a component of the traditional definition of project success was ranked lowest among process project items.

4.4. Summary

Summarizing the 22 papers and conference proceedings used in this study to answer R.Q.1.

We categorized the successful factors in to the two different groups of input project success factors that act as an input for each project for helping us to get better results and output project success factors that characterize the results of the project.

The input success factors are good requirements, user involvement, project management, planning and projects goals, team skills and team working and communication, (see Figure 4).

The output success factors based on their appearance in the studied papers are schedule and budget estimation, customer needs and satisfaction, job satisfaction, functionality, quality and performance (see Figure 5).

To respond to R.Q.2. , in this literature review, we observed different perceptions of software project success based on the information in ((Egorova et al. 2009), (Berntsson-Svensson and Aybüke, 2006) and (Pereira et al. (2008)). Due to the different roles of stakeholders, various organizations and cultural differences, different perceptions of successful software projects occur. We also observed uniformity in the views of Agarwal and Rathod (2006) and Procaccino et al. (2005) research. Brief descriptions of each article are provided below.

In the empirical study by Egorova et al. (2009), they distinguished three types of perspectives based on the role of stakeholders. They found that since their work is evaluated depending on the returns from the investments and economic benefits for the company, business-oriented stakeholders like senior managers, business analysts, and market experts gauge success based on revenue and customers. On the other hand project managers are evaluated based on schedule and budget, delivery precision, project cost, and the views of all those company stakeholders that are directly involved in the product development, base project success, on the quality of the final product.

The empirical study of Berntsson-Svensson and Aybüke (2006), complete and accurate requirements from project start and having enough time for requirements elicitation were considered as two important factors for project success in the financial services, consulting, and telecommunications industries.

Good relations between personnel was seen as the most important factor for project success by subjects from the telecommunications industry, while subjects from the financial services industry saw this as one of the least important factors.

Overall, “good requirements” and “committed sponsor” were counted as important factors for project success from the financial services industry subjects, while these two factors were seen as two of the three least important factors by subjects in the consulting industry, and subjects in the telecommunications industry rated committed sponsor among the three least important factors for project success

It is surprising to see that a “good schedule” is not seen as an important factor for any of the industries.

In Pereira et al. (2008), cultural differences led to different perceptions of successful software projects. On one side the U.S. respondents were more product-focused on meeting user requirements. They were also less risk-averse than people in Chile because of this focus and were more interested in satisfying user requirements and product needs than in scheduling estimates. Conversely, the Chilean respondents were process-focused and ranked estimation and schedule highly.

In Agarwal and Rathod (2006), meeting the scope of software projects which comprises the functionality and quality of the project outcome, was the highest determinant of success. Project time and cost were the two other important factors for three different interest groups of programmers, project managers and customer accounts managers in this research. A limited number of practitioners also considered customer satisfaction and project specific priorities as important criteria in addition to the three core parameters.

In Procaccino et al. (2005), software developers, programmers, data base developers, and system analysts agreed on intrinsic items like internally motivating work, meeting customer' needs, and easily applied product, also finishing a project with budget was ranked lowest among process project items.

4.5. Limitations

In order to ensure the validity of our conclusions, we collected as many papers as possible from an appropriate variety of sources including ACM, IEEE, and web of science. We included as many alternatives as possible for the keywords when formulating the search strings. In addition, the publication year was set to be from 2003 to 2012, which was wide enough to capture most of the relevant publications due to the fact that common project success factors and different viewpoints related to the success of software projects are not much older than one decade. So, it was possible to observe the trends in the area over the past decade.

We kept the gap between conducting searches in different sources to less than one week, and finally updated the results in May 2013 to ensure capturing all studies published in 2012.

Some papers may have been missed due to application of constraints on the search strings in order to reduce the number of irrelevant papers found in the searches. We do not claim to have collected all relevant studies, but included as many studies as possible. It should also be noted that although some studies may have been missed, there is no reason to believe that they would be distributed differently across the classifications than the papers included in the systematic map presented.

In summary, we can claim that although the findings of similar studies may be slightly different from the findings of this research regarding numbers and figures; it will not change the patterns we have identified.

5. Discussion and conclusions

The current literature research has been carried out to find the factors leading to software project success from different viewpoints. The majority of the existing research literature is in the form of industrial experience reports.

Linberg (1999), Procaccino and Verner (2002), found that important factors in project success are perceived differently among different industry domains, different cultures and countries. We have observed the same result regarding different stakeholder viewpoints regarding software project success in our systematic review (see (Egorova et al. 2009), (Pereira et al. 2008), (Agarwal & Rathod, 2006), (Procaccino et al. 2005)).

Successful software projects have been described in many research works as projects that are completed within budget, on schedule, and that meet business objectives ((Baccarini, 1999), (Linberg, 1999), (Jones, 1995)) our systematic mapping documented different viewpoints regarding the role of schedule and budget factors on project success. In recent studies (e.g. (Procaccino et al. 2005), (Berntsson-Svensson &

Aybüke, 2006)) the participants gave the least importance factor to the cost target set for the project, while the results in (Agarwal & Rathod, 2006), (McLeod, 2011) and (Sumner et al. 2006) concluded that cost, time, human resources and quality targets are instrumental and beneficial for the evaluation of project performance and project success.

By reviewing these 22 selected articles, we concluded that different stakeholders involved in software development, may attribute success to different indicators, based on their role in a development team, cultural differences and their role in different organizations. However, a form of consensus exists among different software practitioners on the definition of success in Agarwal and Rathod (2006) and Procaccino et al. (2005) articles.

In the studied papers, the most important successful input and output factors are good requirements and time and cost estimation out of the 6 and 4 factors studied, respectively. So knowing these factors assists the development team to gain better results and eliminate the risk of failure in the future.

Further research could be carried out to complete this systematic mapping with a systematic review. This research can be also extended by studying particular software development strategies, like agile development and global software engineering. Additional papers extracted from different database, might also be investigated in order to provide as much input as possible for analyzing the current status of the area.

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